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Observations of the Eclipse of Iapetus in the Shadows of the Globe, Crape Ring, and Bright Ring of Saturn, 1889 *November* 1.

By E. E. Barnard, M.A., Astronomer of the Lick Observatory.

Astronomers are, indeed, indebted to Mr. A. Marth for his keen foresight of some of the rarer phenomena of the planets and satellites that are out of the regular line of the almanac predictions.

A brilliantly clear sky and ordinarily good seeing here on the morning of November 2, permitted observations of a portion of the series of eclipses of *Iapetus* in the shadows of the globe and ring-system of *Saturn*, to which attention had been called by Mr. Marth in the June number of the *Monthly Notices*.

Professor Holden requested me to observe this phenomenon with the 12-inch equatorial, as it would be out of the reach of the great telescope.

As soon as *Saturn* became visible above the horizon I examined it, and made a sketch of the positions of the satellites for reference later.

At sidereal time, $4^h\ 30^m$, *Titan*, *Tethys*, *Enceladus*, *Dione*, and *Rhea* were visible, as given in the order of right ascension; the two last were following the planet. *Tethys* and *Enceladus* were quite near each other, close preceding the end of the ring. A sharp watch was kept at the approximate point of reappearance of *Iapetus* from the shadow of the globe. The time was recorded every few minutes, and a note made that the satellite was not visible. The last of these was at $5^h\ 17\frac{1}{2}^m$ sidereal time, when no trace of the satellite could be seen. At $5^h\ 25^m$ sidereal time the satellite was faintly caught, and for at least one half minute before this it was seen, but so faint and uncertain that it was not recorded. At the above time it was about as bright as *Enceladus*. Its light increased pretty rapidly. The point of appearance formed a right-angled triangle with *Tethys* and *Enceladus*, the right angle at *Tethys*, *Iapetus* being nearly due north of that satellite.

The idea at once occurred that it would be an excellent plan to test the effect of the shadow of the crape ring on the visibility of the satellite, by frequent comparisons of the light of *Iapetus* with that of *Tethys* and *Enceladus*. A series of comparisons was therefore begun. The standard of comparison was the difference of brightness between *Tethys* and *Enceladus*—this quantity being mentally divided into ten equal parts. Seventy-five such comparisons were made during the visibility of *Iapetus*. I have constructed a curve from these, using normals, of three estimates each, between comparisons 6 and 74, and through the points so found I have drawn the curve that best represents them (see figure, where the single comparisons are represented by dots, and where the curve is drawn by the aid of the normals). I have laid off time on the axis of x, and brightness on the axis of y.

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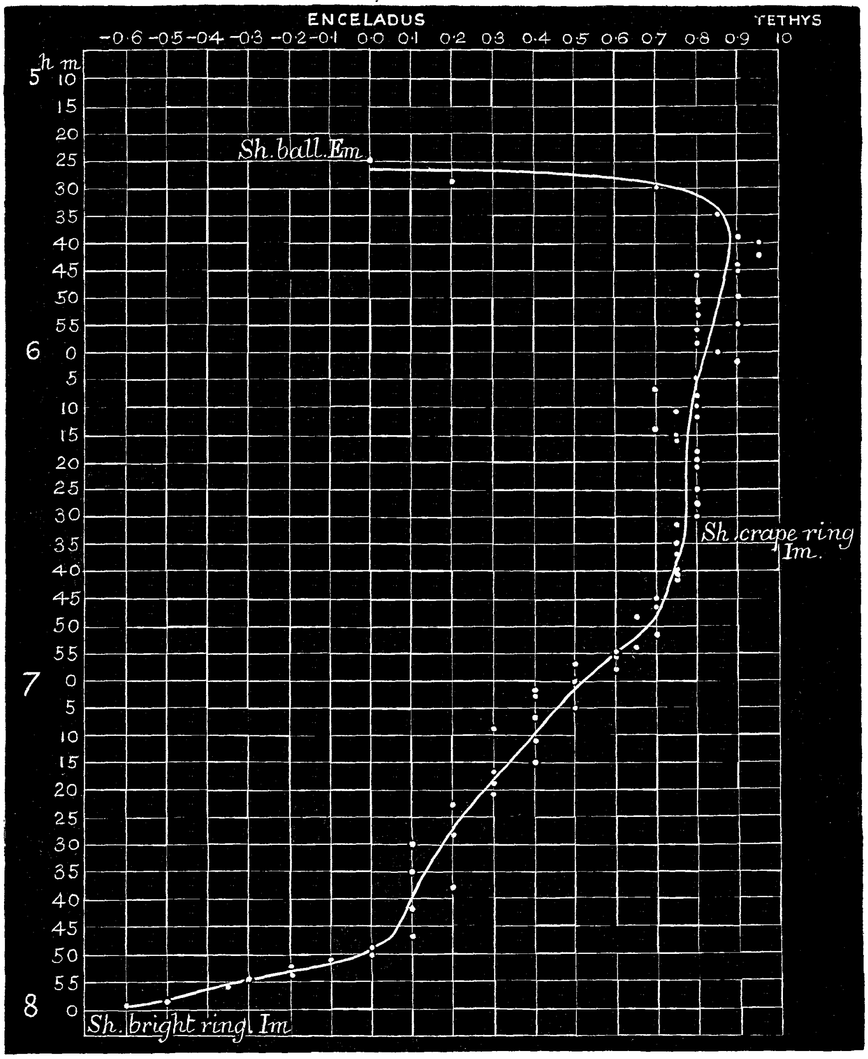
The records that follow are in local sidereal time, as were the preceding.



Light Curve of the Eclipse of *Iapetus*, in the shadows of the Globe, Crape Ring, and Bright Ring of *Saturn*, 1889 Nov. 1.

If we examine the curve we shall see that the satellite quickly attained its maximum light at about $5^{h}\ 35^{m}$. After this there was seemingly a slow decrease until about $6^{h}\ 15^{m}$. From this time until $6^{h}\ 35^{m}$ the light of the satellite seemed to be constant or almost imperceptibly to diminish. At $6^{h}\ 35^{m}$ a steady and decided decrease commenced and continued until $7^{h}\ 50^{m}$, when the satellite began rapidly to disappear, the curve sinking quite sharply.

I do not understand the slight decrease of light so soon after the maximum had been reached, as it is evident from the curve that the satellite did not experience the effects of the crape ring until near $6^{h}\ 35^{m}$. If, however, we consider that the varia-

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tion of light between $5^h\ 40^m$ and $6^h\ 15^m$ represents only 0·1 of a magnitude, it has less signification. (I am assuming with Prof. Pickering that the difference between *Enceladus* and *Tethys* was only one magnitude. See *Harvard College Observatory Annals*, vol. xi. p. 269. To me the difference in their light appeared somewhat greater than this.) I would rather refer this peculiarity to the fact that the seeing became better, and a fairer estimation could therefore be made of the relative light; if so, the curve should be flatter near $5^h\ 35^m$, to correspond with that near $6^h\ 25^m$.

This curve shows admirably how the semi-shadow of the crape ring affected the visibility of *Iapetus*. There was a regular decrease of the light of the satellite caused by this shadow, from $6^h\ 35^m$ to $7^h\ 45^m$, at which time *Iapetus* evidently struck the shadow of the inner bright ring into which it disappeared, being last seen at $7^h\ 59^m$.

The observations show that after passing through the sunlight shining between the ball and the rings, *Iapetus* entered the shadow of the crape ring. As it passed deeper into this the absorption of sunlight became more and more pronounced, until finally the satellite entered the shadow of the bright ring.

In a word, then, the crape ring is truly transparent—the sunlight sifting through it. The particles composing it cut off an appreciable quantity of sunlight. They cluster more thickly, or the crape ring is denser as it approaches the bright rings.

A magnifying power of 150 was used throughout on the 12-inch. The seeing ranged from 2 at the first observations of *Iapetus* up to 5 as dawn appeared.

Enceladus was last seen very faintly at $8^h\ 52^m$ sidereal time, and had certainly disappeared in the whitening sky at $8^h\ 53^m$.

Tethys disappeared at $8^h\ 57^m$; this was the last glimpse of it, the sky being quite white.

The following are the important instants, in Mount Hamilton mean time:—

	h	m	
Iapetus first certainly seen at	14	37·4,	November 1, 1889.
„ last „ „ at	17	11·0,	November 1, 1889.

The superb definition of the planet in the last part of the observations showed no abnormal appearance of the rings where the shadow of the ball crosses them, nor have I at any time seen a white spot on the rings at this or any other point.

In the diagram of the curve, the vertical column of figures represents the sidereal times of the individual estimations, while the horizontal column above gives the difference of light between *Enceladus* and *Tethys* in steps of one-tenth each.

The observations of the disappearance of the satellite (*Iapetus*) into the shadow of the bright ring show that, so far as the penetration of the solar rays is concerned, the bright ring is fully as opaque as the globe of *Saturn* itself.

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Table of Light Variations of Iapetus.

November 1, 1889.

No.	Local Sid. Time. h	m	Estimated Relative Light.
1	5	25·0	0·00
2		29·0	0·20
3		30·0	0·70
4		35·0	0·85
5		39·0	0·90
6		40·0	0·95
7		42·5	0·95
8		44·0	0·90
9		45·0	0·90
10		46·0	0·80
10½		50·0	0·90
11		51·0	0·80
12		53·0	0·80
13		55·0	0·90
14		56·0	0·80
15		58·0	0·80
16	6	0·0	0·85
17		2·0	0·90
18		5·0	0·80
19		7·0	0·70 "fainter."
20		8·0	0·80 "not fainter."
21		10·0	0·80
22		11·0	0·75 "fainter."
23		12·0	0·80
24		14·0	0·70 "fainter."
25		15·0	0·75
26		16·0	0·75
27		18·0	0·80
28		20·0	0·80
29		21·0	0·80
30		25·0	0·80
31		27·5	0·80
32		30·0	0·80
33		32·0	0·75
34		35·0	0·75
35		37·0	0·75
36		40·0	0·75
37		41·0	0·75
38		42·0	0·75
39	6	45·0	0·70
40		46·5	0·70
41		48·0	0·65 "decidedly fainter."
42		52·0	0·70
43		54·0	0·65
44		55·0	0·60
45		55·5	0·60
46		57·0	0·50
47		58·0	0·60
48	7	0·0	0·50
49		2·0	0·40
50		3·0	0·40
51		5·0	0·50
52		7·0	0·40
53		9·0	0·30
54		11·0	0·40
55		15·0	0·40
56		17·0	0·30
57		19·0	0·30
58		21·0	0·30
59		23·0	0·20
60		28·0	0·20
61		30·0	0·10
62		35·0	0·10
63		38·0	0·20
64		42·0	0·10
65		47·0	0·10
66		49·0	0·00
67		50·0	0·00 "perhaps slightly less."
68		51·0	−0·10
69		52·5	−0·20
70		54·0	−0·20
71		54·5	−0·30
72		56·0	−0·35 "v. v. faint."
73		58·0	−0·50 "e. e. faint."
74		59·0	−0·60 "e. e. e. faint."
75	8	1·0	"no trace of it."
76	8	5·0	” ”

Mount Hamilton :
1889 *November* 22.